THE WEATHER AND CIRCULATION OF DECEMBER 1953 [1]

A Month of Fast Westerly Flow

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WAVE PATTERN AND WIND FIELD

The monthly mean circulation pattern at 700 mb. for December 1953 was characterized by four pronounced regions of positive height anomaly at middle and lower latitudes, while large negative centers were located over Greenland and northeastern Canada, the central Pacific, and the southeastern Atlantic (fig. 1). The positive areas were associated with northward extensions into middle latitudes of subtropical high cells in the western Pacific, eastern Pacific, western Atlantic, and the Mediterranean. Except for the European ridge, which was essentially meridional in character, these positive anomaly regions were oriented zonally and overshadowed areas of negative anomaly south of about latitude 50° N. In addition, these areas were arranged in a wavelike pattern with fairly uniform longitudinal spacing, especially between the western Pacific and the central Atlantic. Poleward of latitude 50° N. heights were predominantly below normal, not only in the major troughs over eastern Canada, the central Pacific, and northeastern Siberia, but even in the well-defined ridge over western Canada. Thus at middle latitudes the 700-mb. contours formed a broad cyclonic pattern over wide longitudinal zones from eastern Asia to the eastern Pacific and from central North America to the central Atlantic.

These features of the mean 700-mb. chart compose what is usually termed a typical high index circulation pattern. Figure 2A portrays the simple nature of this broad westerly flow from eastern Asia into the central Atlantic. In general, over a large part of the hemisphere there was a single, well-defined axis of maximum wind speed which did little meandering. It was only over the eastern Atlantic and Europe that a pronounced split in the basic current was observed. The strongest winds were located over the Pacific in association with the deep Aleutian Low and central Pacific trough (fig. 1). In fact, the maximum speed center was located just slightly to the rear of this major trough at latitude 40° N. in a long, zonally oriented belt of strong winds exceeding 16 m/sec which stretched clear across the ocean from Korea to near the coast of Washington. A similar belt of winds in excess of 16 m/sec extended from the Mississippi River eastward to the central Atlantic and thence northeastward to the vicinity of Iceland. The maximum speed center southeast of Newfoundland was located due south of the abnormally deep cyclone center at the southern end of Greenland.

Figure 2B reveals in striking fashion the considerable anomaly of the 700-mb winds during the month. Most sections of the hemisphere north of 35° N. experienced mean wind speeds in excess of normal. The greatest positive anomalies were located in northeastern sections of both the Pacific and the Atlantic. While wind speeds over the North American continent were weaker than over the oceans on both an absolute and relative basis, they were predominantly above normal. Probably of most direct significance to the weather of the United States during the month were the stronger-than-normal westerlies which struck the Pacific Coast from British Columbia to Oregon, crossed the northern Rockies into the Northern Plains, and then fanned out into a more diffuse stream over the central United States (figs. 1 and 2). Other abnormally strong winds over the United States were observed from the lower Mississippi Valley northeastward to New England. This axis of positive wind anomaly lay some 10° of longitude to the east of, and virtually parallel to, the central United States trough.

It is interesting to note that December 1953 was the eighth consecutive month during which the temperate westerly (35°–55° N.) index at 700 mb. for the Western Hemisphere was higher than normal. The period from the second half of November through December represented the culmination of this abnormality as index values reached a maximum anomaly of +2 m/sec. It is also noteworthy that the general character of the circulation throughout this period of maximum index (i. e., from mid-November through December) remained essentially fixed. This can be seen by comparing figure 1 with figure 1B of last month's article [1]. It was shown there how the circulation during the second half of November represented a large break from the prevailing flow of the first half of the month. December's circulation pattern resembled that of November 16–30 in almost every detail except that the southern end of the Pacific trough progressed from western to central sections of the ocean and a slight increase in wave amplitude took place.

[1] See Charts I-XV following p. 404 for analyzed climatological data for the month.

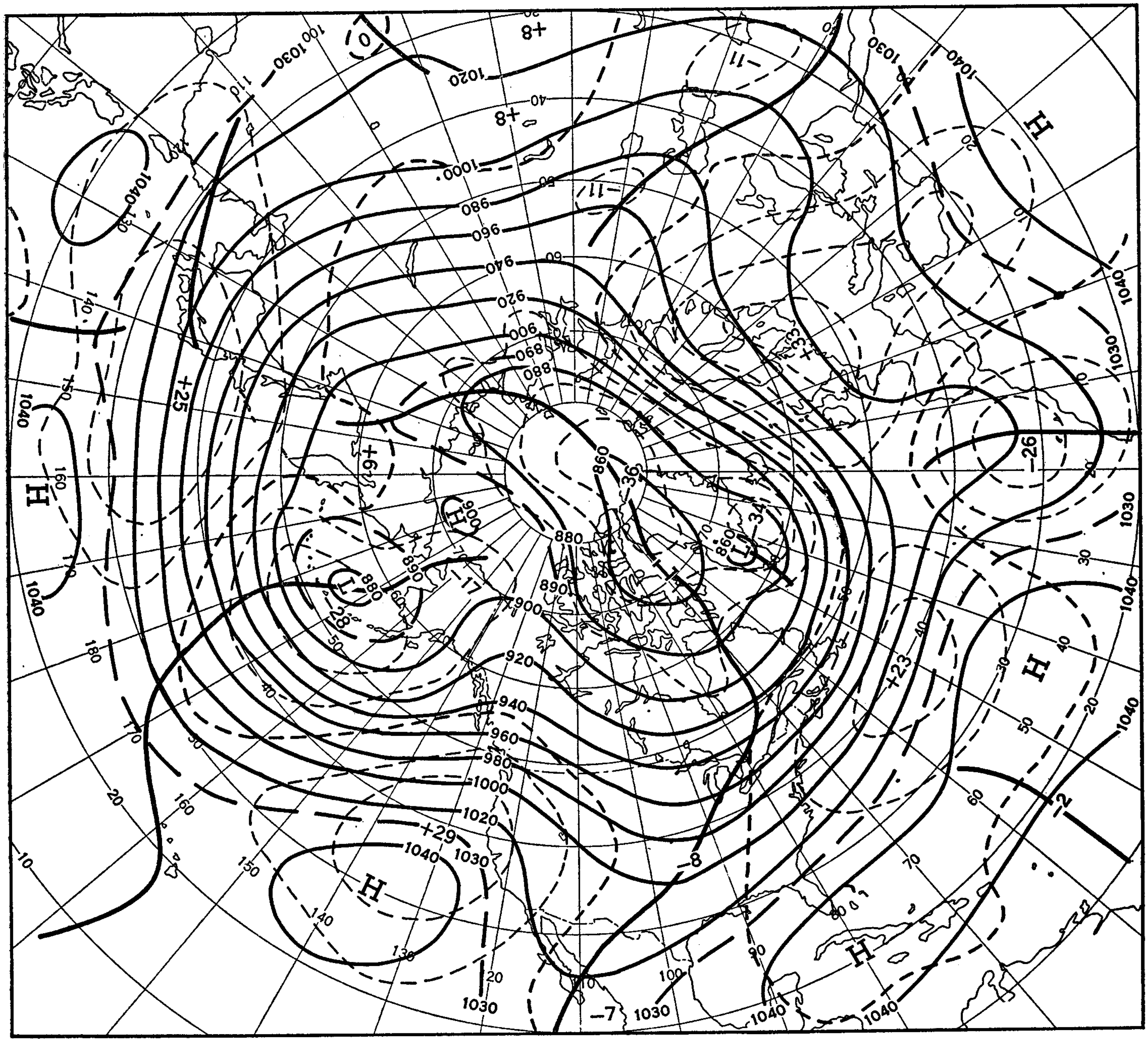


Figure 1.—Mean 700-mb. chart with height contours and departures from normal (both labeled in tens of feet) for November 29–December 28, 1953. Below-normal heights prevailed north of latitude 50° N. while positive anomalies were dominant in the subtropical ridges from eastern Asia eastward to the central Atlantic.

Thus a nearly steady-state circulation over virtually the entire hemisphere accompanied the sustained high index of the last month and a half of 1953.

RELATED CYCLONE TRACKS, FRONTS, AND PRECIPITATION

Fast westerly flow had a decided effect on the tracks of cyclones in the North American region during December. The outstanding storm track, along which storminess was extremely frequent, extended from the Gulf of Alaska eastward across southern Canada and thence northeastward to the Iceland-Greenland area (Chart X and fig. 3B). Many cyclones formed east of the mountains in Alberta, triggered by perturbations moving in from the Pacific, while some Pacific storms actually moved across the mountains. Several of these storms were deep as they moved through western Canada with central pressures often below 1000 mb. Monthly mean sea level pressures averaged 7 mb. below normal over northern Alberta and also significantly below normal along the storm track from the Aleutians to southeastern Canada and near the Iceland-Greenland region (Chart XI inset). Hence a clear channel of low pressure along the line of this major storm track was in evidence on the mean sea

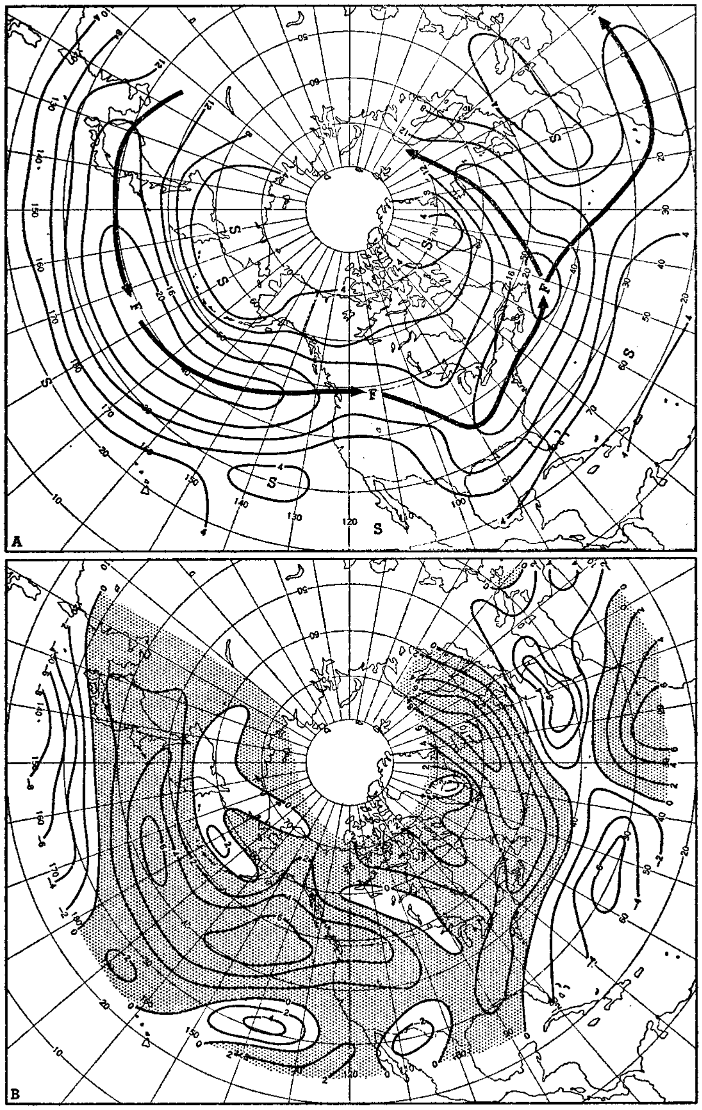


FIGURE 2.—Mean 700-mb. isotachs (A) and departure from normal wind speed (B) (both in meters per second) for November 29–December 28, 1953. Note broad bands of strong winds over oceanic areas and eastern United States. Wind speeds were predominantly in excess of normal north of about 35° N.

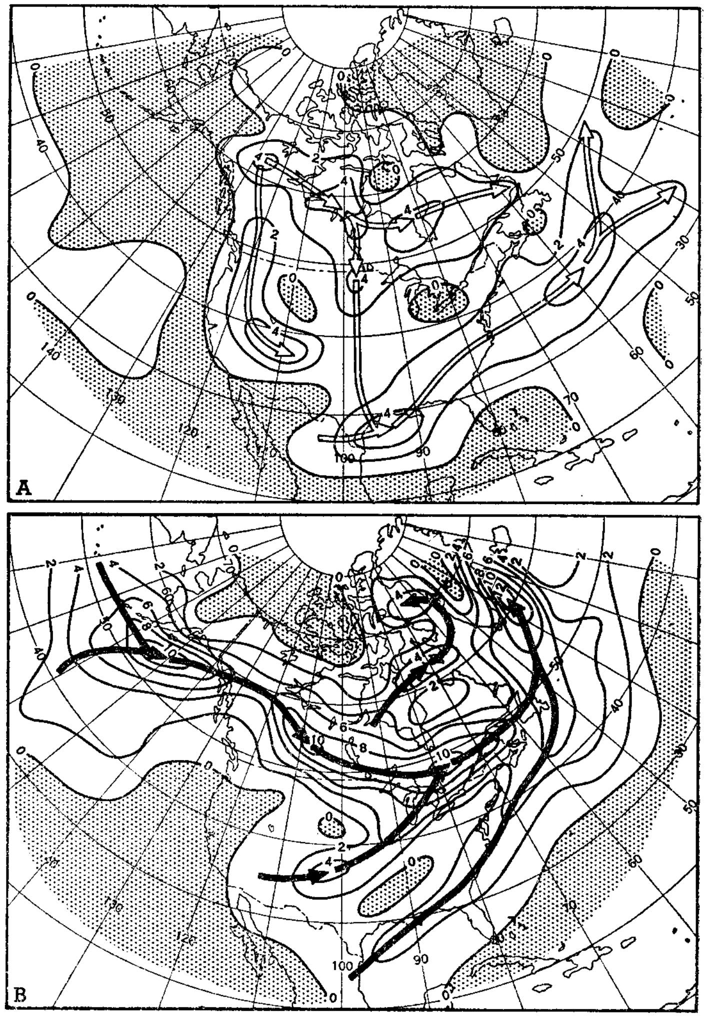


FIGURE 3.—Frequency of (A) anticyclone passages and (B) cyclone passages (within 5° squares at 45° N.) during December 1953. Well-defined anticyclone tracks are indicated by open arrows and cyclone tracks by solid arrows. Outstanding feature is the great concentration of cyclones traveling from the Gulf of Alaska eastward just north of Canadian-United States border and thence northeastward to the east side of Greenland. Of great importance to the precipitation regime over the United States were two parallel cyclone tracks originating over the Plateau and over the western Gulf of Mexico with a distinct minimum of cyclones in between, resulting in distinctly separate bands of heavy precipitation over eastern and central United States (Chart III-B).

level chart (Chart XI). The storm track paralleled the mean 700-mb. contours closely from northern British Columbia into the northern Atlantic (fig. 1) and remained in the cyclonic shear zone, poleward of the axis of maximum wind speed (fig. 2A). Closely related to the predominant storm track across Canada was a west-east zone of maximum frequency of surface frontal systems (fig. 4). As might be anticipated from the usual nature of fast-moving polar-front cyclones, this maximum concentration of fronts was generally located on the south side of the storm track. Along the Pacific Coast and in the eastern Pacific the displacement between the storm track and the region of maximum frontal frequency was quite large. This was related to the fact that many of the cyclones entering the Gulf of Alaska were of the old occluded type in which fronts no longer existed near the centers. In typical fashion frontal systems southeast of these Lows remained strong as they approached the Pacific Northwest steered by the main belt of fast westerlies.

Figure 3B shows that a few Alberta Lows traversed portions of the central northern border States. Aside from these there were several other cyclones affecting the United States during the month. These systems generally traveled along two distinct tracks as indicated in figure 3B. One of these, which was active primarily in the first decade of the month, was the path from the Southern Plateau northeastward across the Central Plains joining with the Alberta Low track northeast of the Great Lakes. The other extended from the Gulf of Mexico northeastward into the Atlantic off Cape Haterras. Both of these tracks are fairly typical during December and the number of storms traversing each of these tracks was probably not abnormal. The east coast track was essentially parallel to the mean 700-mb. contours in that area and also to the trough extending from eastern Canada southwestward to Lower California (fig. 1). The central United States track was also parallel to the trough, but to the rear of it, so that it crossed the mean contours at a comparatively large angle. Meanwhile in the region located within about 10° to 15° of longitude east of the trough (i. e., from Texas northeastward to the Middle Atlantic States) there was virtually a complete absence of cyclones as well as a distinct minimum of fronts (fig. 4). The area just to the east of a well-defined deep mean trough would normally be expected to be the site of frequent storminess and considerable frontal activity. However, the trough over the central United States this month was not especially deep (a maximum of 80 feet below normal over Missouri) and also not too well defined since it was part of a broad cyclonic flow extending from the Rockies to the Atlantic. Thus, cyclonic activity over the States during December probably developed in response to the effects on a broad westerly current of fixed geographic features like the Rocky Mountains and the land-sea boundary along the Gulf and Atlantic coasts.

The precipitation regime over the United States during December was closely related to the aforementioned storm tracks, fronts, and circulation (Chart III–B). Precipitation generally exceeded normal amounts in areas along and north of the two storm tracks over the eastern and central United States; subnormal amounts prevailed along and north of the region of minimum storminess and frontal activity extending from Texas to the Middle Atlantic States. The lack of precipitation on the southeast side of Lows moving northeastward across the Plains States has often been noted. For example, a similar split in heavy precipitation areas associated with two separate storm tracks across the country was recently noted by Klein [2]. Above-normal precipitation occurring along the Canadian border from Montana to Minnesota was associated with some of the Alberta Lows which moved eastward very close to the border. The other region of above-normal precipitation, in Oregon and western Washington, was attributable to the fast westerlies striking the coast in this region (fig. 2) and the accompanying large number of frontal passages (fig. 4). Throughout the remainder of the West prevailing anticyclonic northerly flow (fig. 1) resulted in few fronts (fig. 4) and precipitation amounts which were generally subnormal.

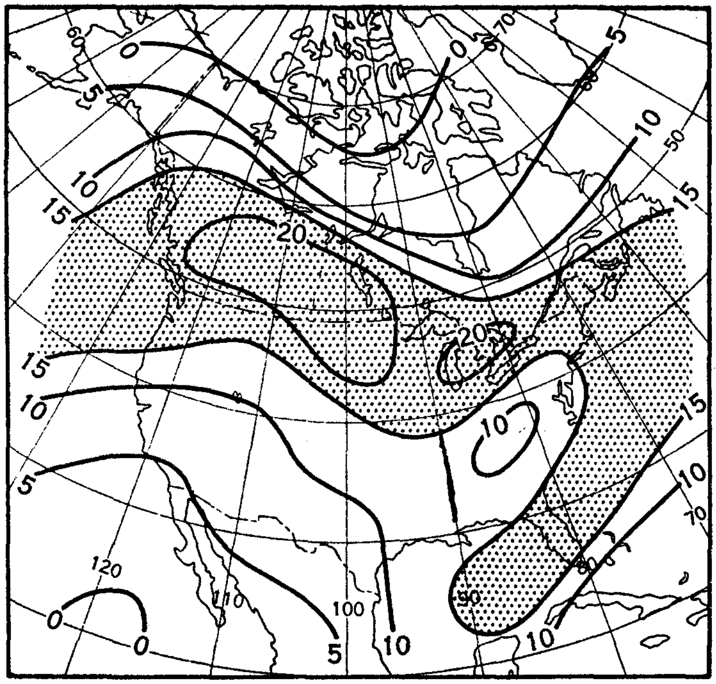


Figure 4.—Number of days with surface fronts (of any type) located within squares approximately 430 nautical miles on a side during the month of December 1953. Areas where fronts were present on 15 or more days are shaded. Zones of maximum frequency were located to the south of major storm tracks along northern border and east coast of United States. (Data from *Daily Weather Map*, 1830 GMT chart.)

TEMPERATURES RELATED TO ANTICYCLONE TRACKS AND CIRCULATION

Temperatures over the United States during December 1953 were greatly influenced by the dominant fast westerly flow prevailing over the Pacific and North America. As shown in Chart I-B the northern half of the country was considerably warmer than normal while the southern half averaged somewhat cooler than normal. In view of the fast westerly flow, the below-normal character of 700-mb. heights and sea level pressures in western and central Canada, and the associated frequency of Alberta Lows moving along the Canadian border, it is obvious that the United States was dominated by air masses of Pacific origin during much of the month. When Canadian polar air did invade the country the westerlies set in rapidly along the northern border so that cold weather was short-lived. Thus the entire northern half of the country was prevailingly warm even though 700-mb. heights were below normal and flow was slightly more northerly than normal over the Northern Plains to the rear of the trough. It was warmest (relative to normal) in the Northeast where heights were considerably above normal and flow was more southerly than normal, and also over Montana and western North Dakota where foehn winds prevailed as Pacific air masses crossed the mountains.

Northerly and northeasterly wind components with respect to normal over the West between the eastern Pacific ridge and the southwestern portion of the United States trough (fig. 1) were largely responsible for cold air in the Southern Plateau and Southern Rockies. The mean 700-mb. contours transported Pacific air masses of middle latitude origin into regions where normally flow is weaker and comes from lower latitudes of the Pacific. These Pacific air masses had little opportunity to warm appreciably as they traversed the broad region of pronounced cyclonic flow associated with the trough so that the South and Southeast experienced below-normal temperatures.

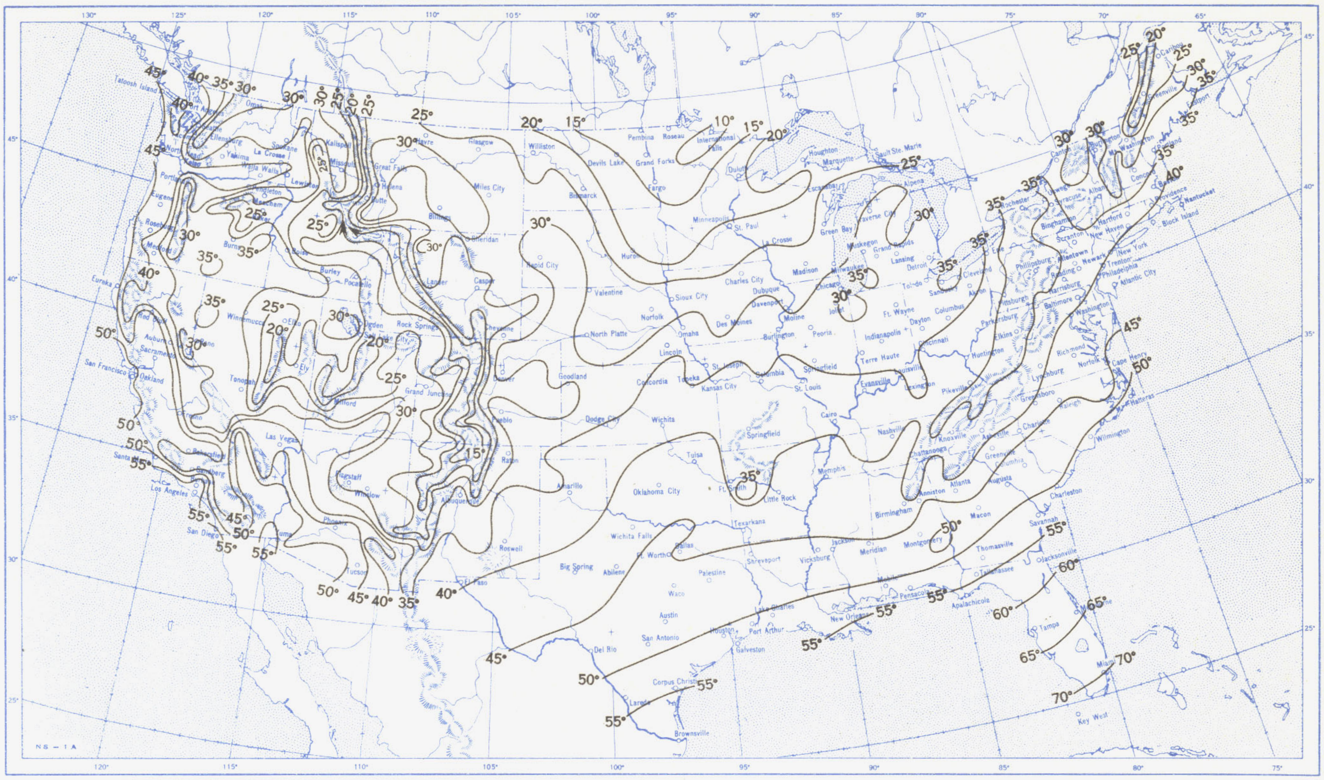
The Southeast was also cooled by a few outbreaks of Canadian polar air which plunged southward on occasions when the flow pattern over the United States became more meridional. The tracks of these polar anticyclones are shown in Chart IX and in summary form in figure 3A. For the most part, however, the major track for Canadian anticyclones was eastward through Canada under the prevailing mean westerly flow and to the north of the major cyclone track shown in figure 3B. Over the Great Basin mean sea level pressure was prevailingly high (Chart XI). This high pressure was made up by several quasi-stationary daily Highs most of which originated as offshoots from the subtropical Pacific high cell (fig. 3A and Chart IX). In turn offshoots from these Basin Highs led to anticyclogenesis in the West Gulf. Several of these anticyclones moved northeastward through the Carolinas and out into the Atlantic. The high frequency of anticyclones over the Southeast permitted considerable radiational cooling so that, even when Canadian air was not present, minimum temperatures were often quite low.

As fast westerly flow continued at middle latitudes during December cold air accumulated over northern sections of Canada, mainly in the region of northerly flow to the rear of the deep trough over eastern Canada (fig. 1). As the month came to a close cold air began to occupy most of Canada, representing a considerable change from the warm state which had prevailed in the region throughout October and November [1].

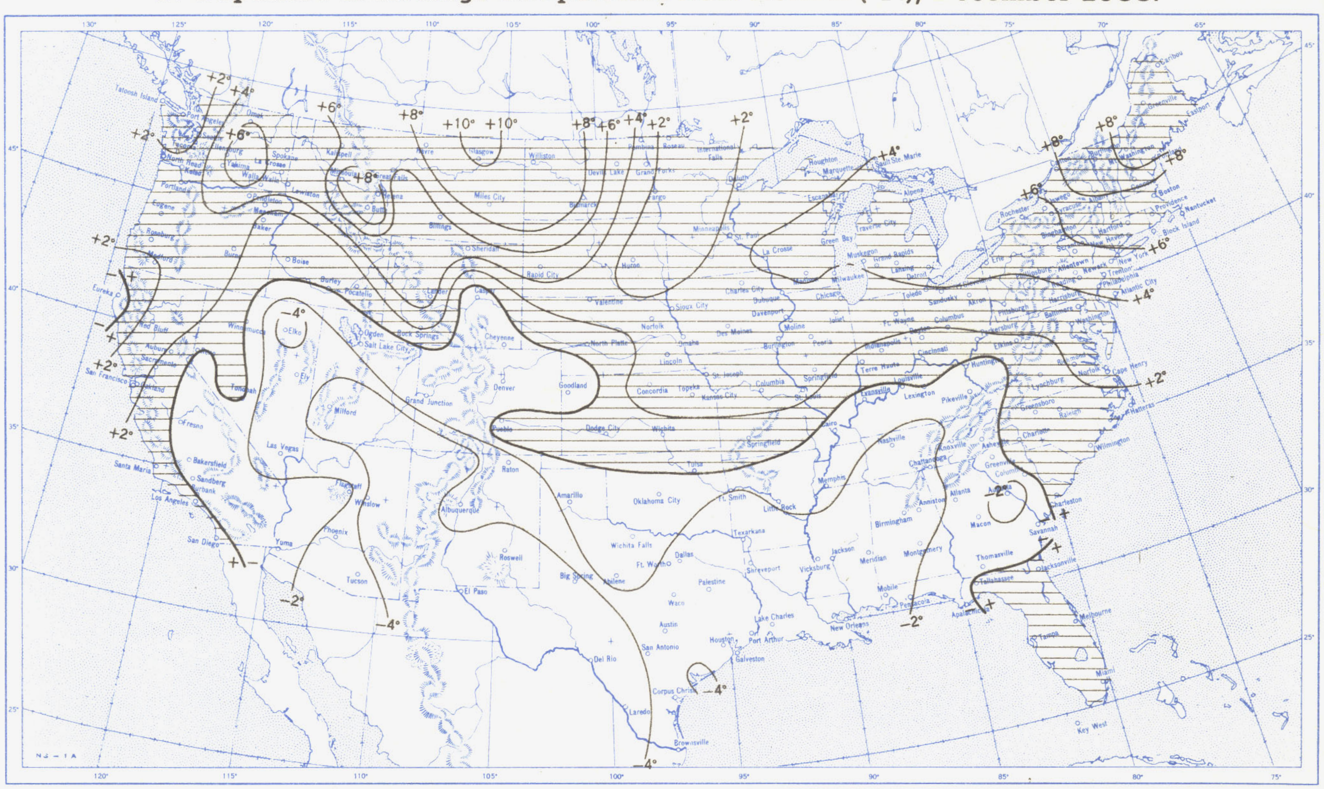
REFERENCES

1. J. S. Winston, "The Weather and Circulation of November 1953—A Month of Contrasting Regimes", *Monthly Weather Review*, vol. 81, No. 11, Nov. 1953, pp. 368–373.
2. W. H. Klein, "The Weather and Circulation of April 1953—A Cold, Stormy Month With a Low Index Circulation", *Monthly Weather Review*, vol. 81, No. 4, Apr. 1953, pp. 115–120.

Chart I. A. Average Temperature (°F.) at Surface, December 1953.

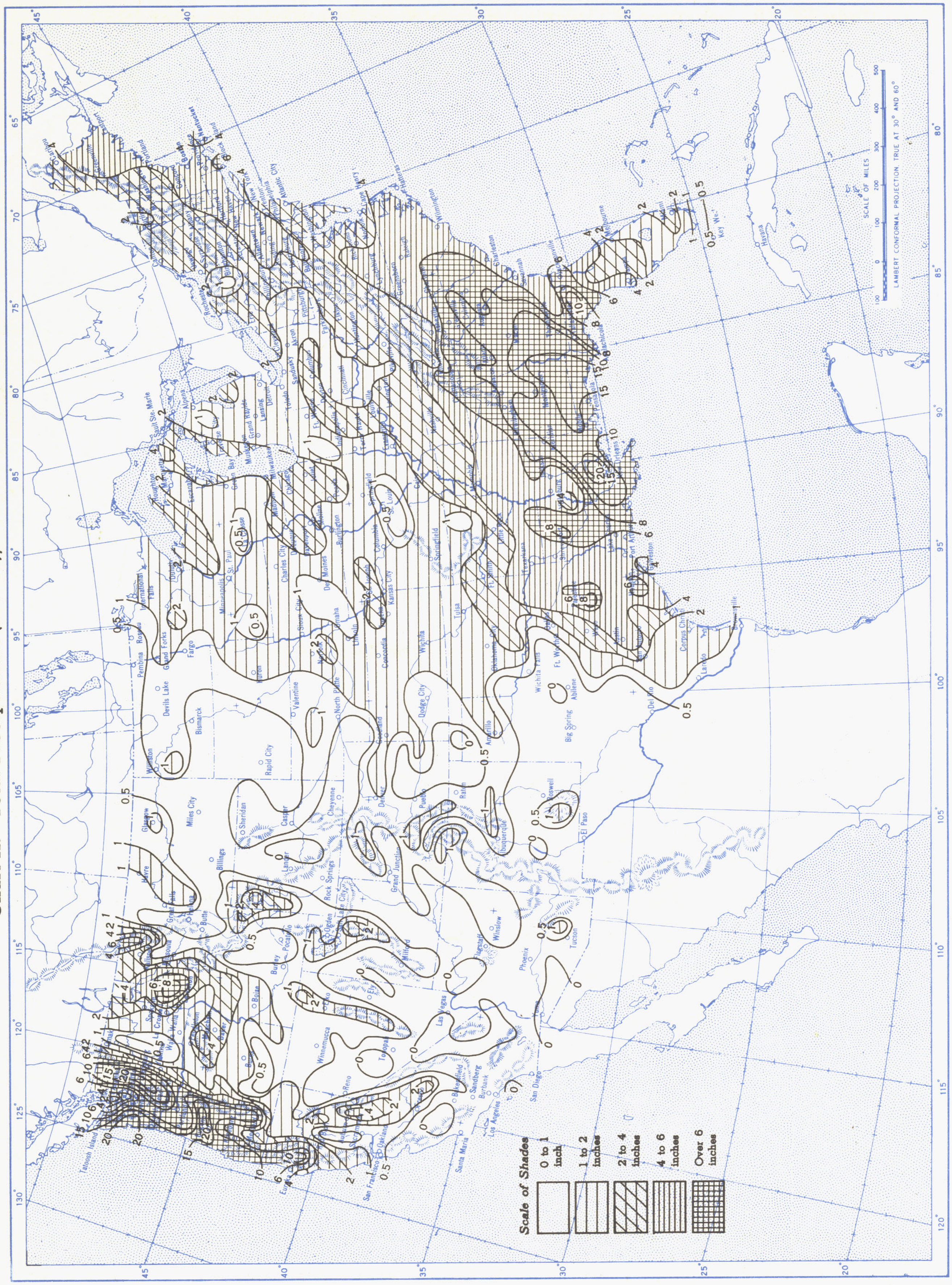


B. Departure of Average Temperature from Normal (°F.), December 1953.



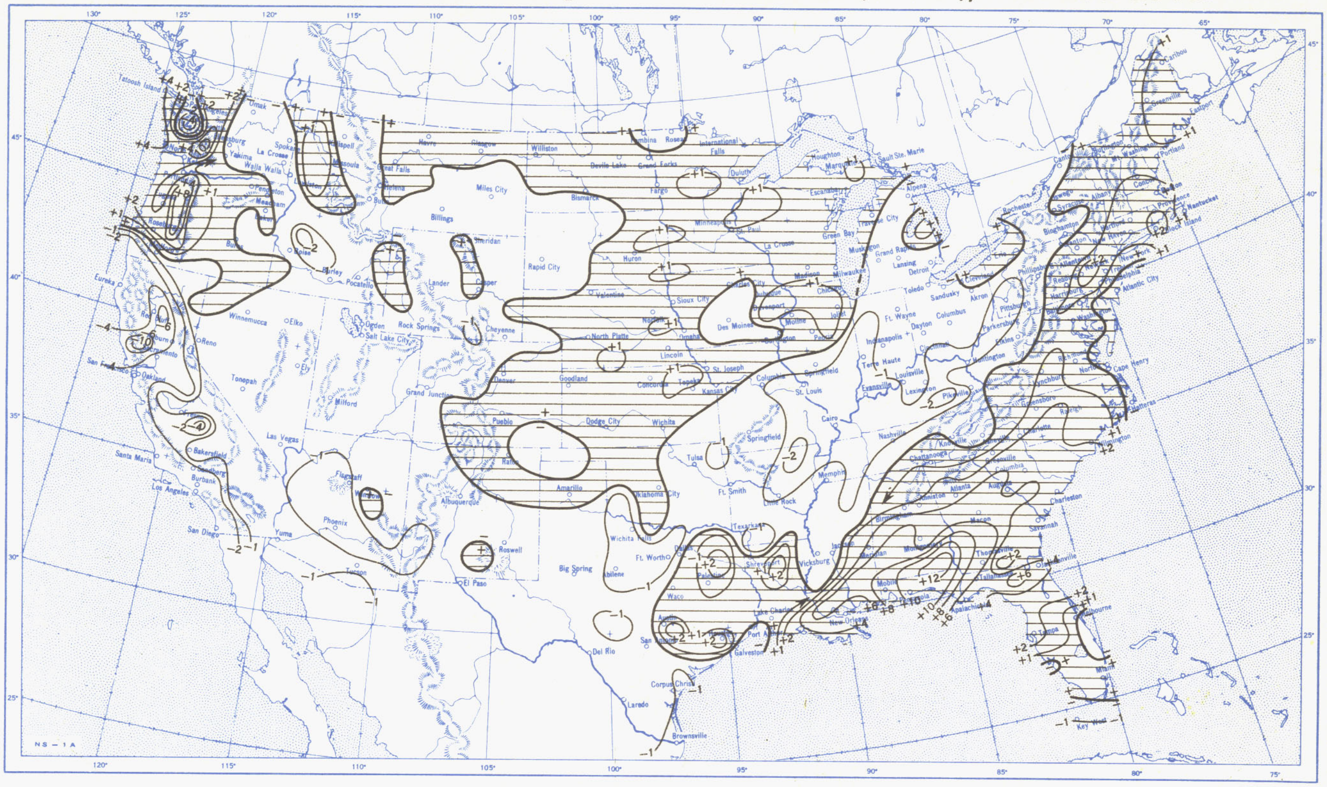
A. Based on reports from 800 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.
B. Normal average monthly temperatures are computed for Weather Bureau stations having at least 10 years of record.

Chart II. Total Precipitation (Inches), December 1953.

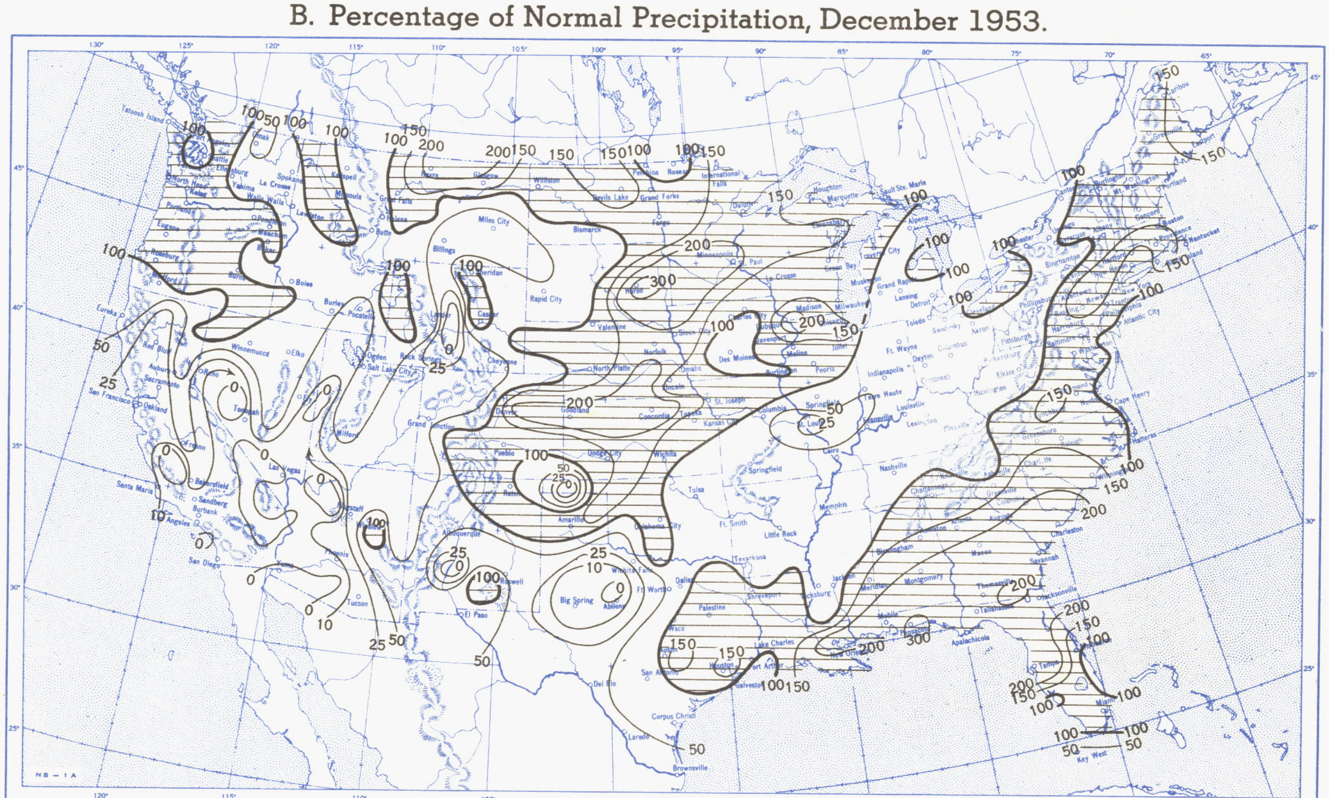


Based on daily precipitation records at 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), December 1953.

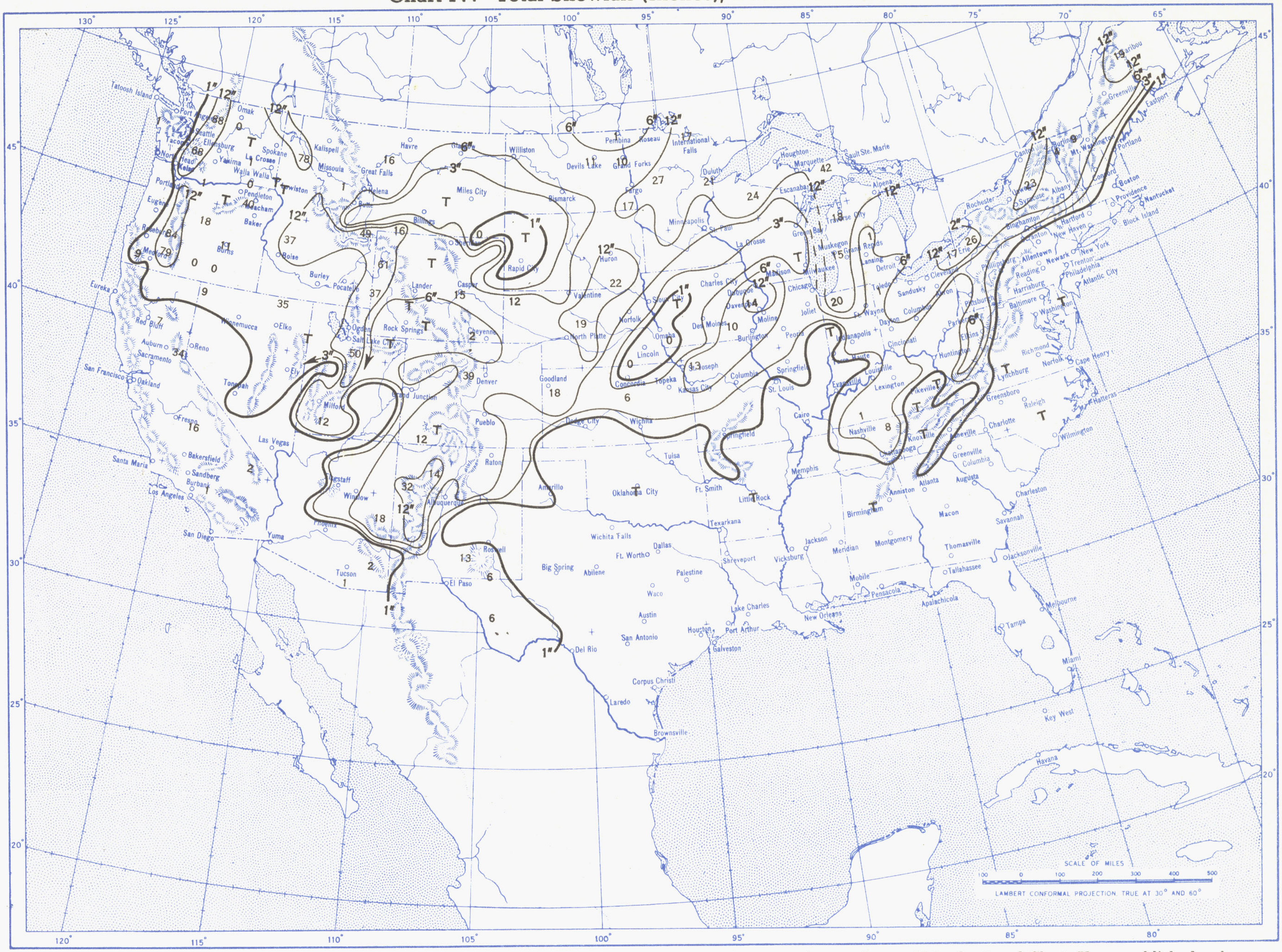


B. Percentage of Normal Precipitation, December 1953.



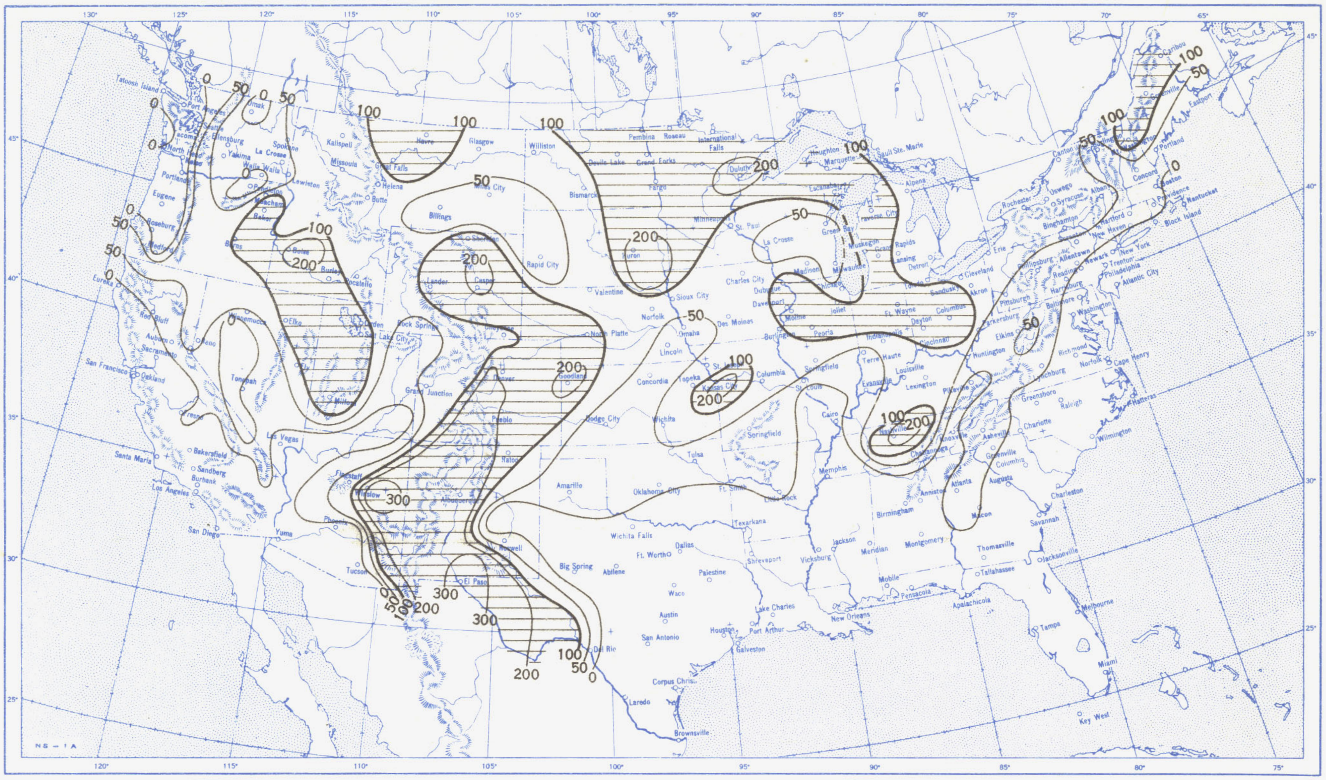
Normal monthly precipitation amounts are computed for stations having at least 10 years of record.

Chart IV. Total Snowfall (Inches), December 1953.

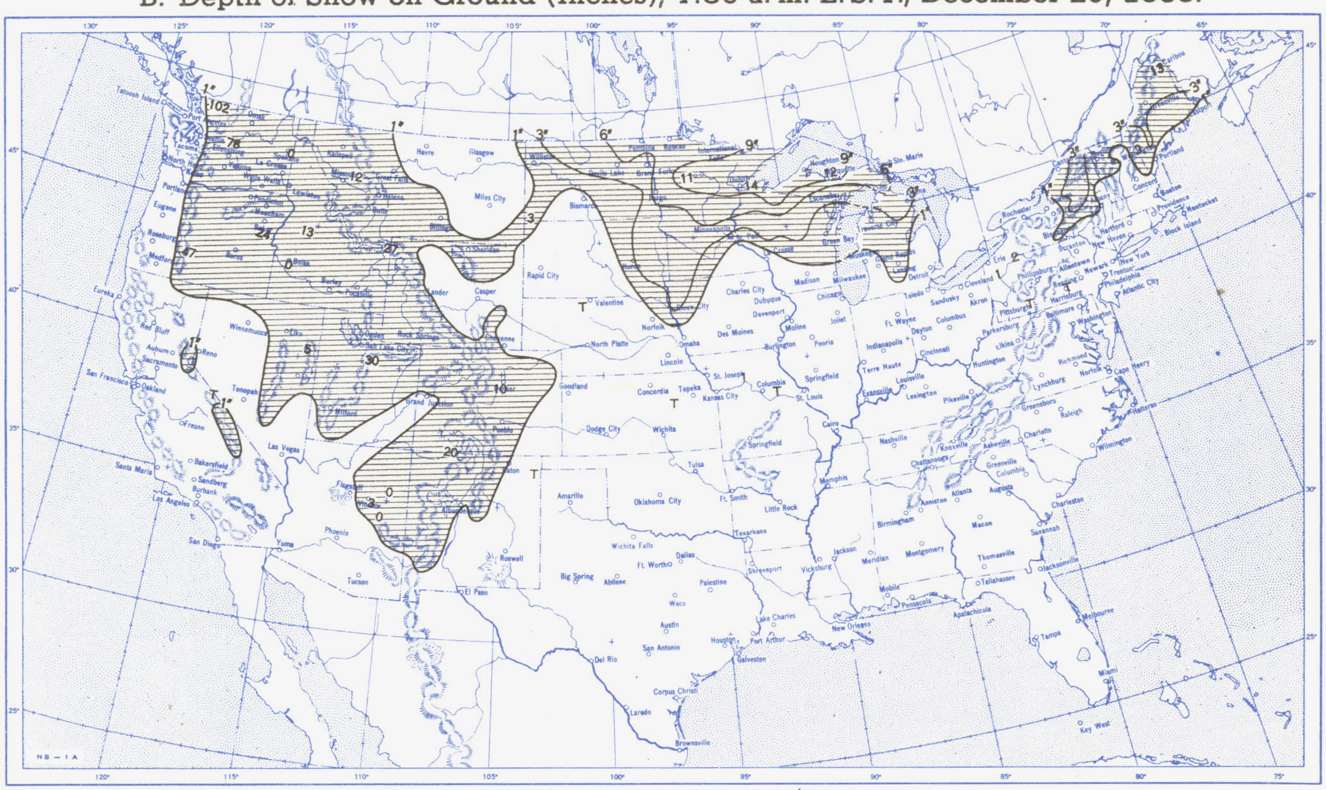


This is the total of unmelted snowfall recorded during the month at Weather Bureau and cooperative stations. This chart and Chart V are published only for the months of November through April although of course there is some snow at higher elevations, particularly in the far West, earlier and later in the year.

Chart V. A. Percentage of Normal Snowfall, December 1953.

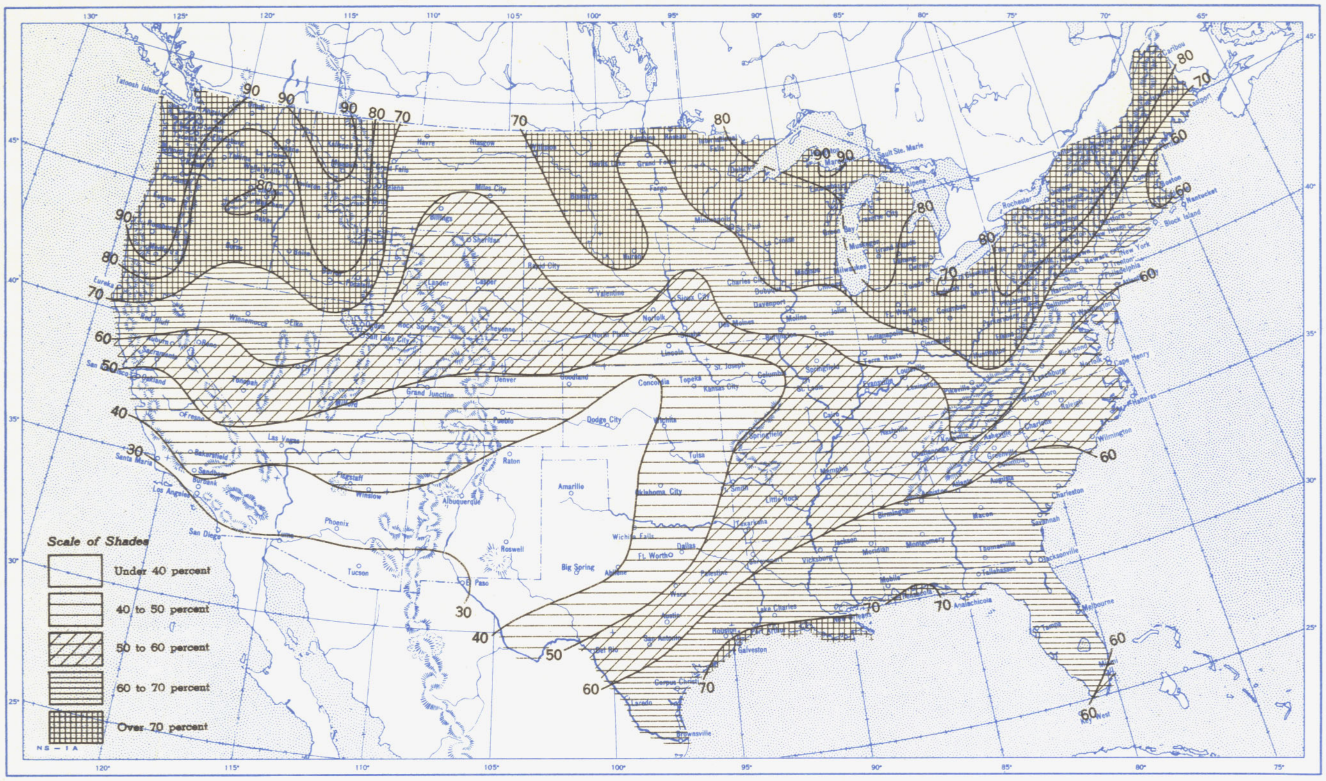


B. Depth of Snow on Ground (Inches), 7:30 a. m. E. S. T., December 29, 1953.

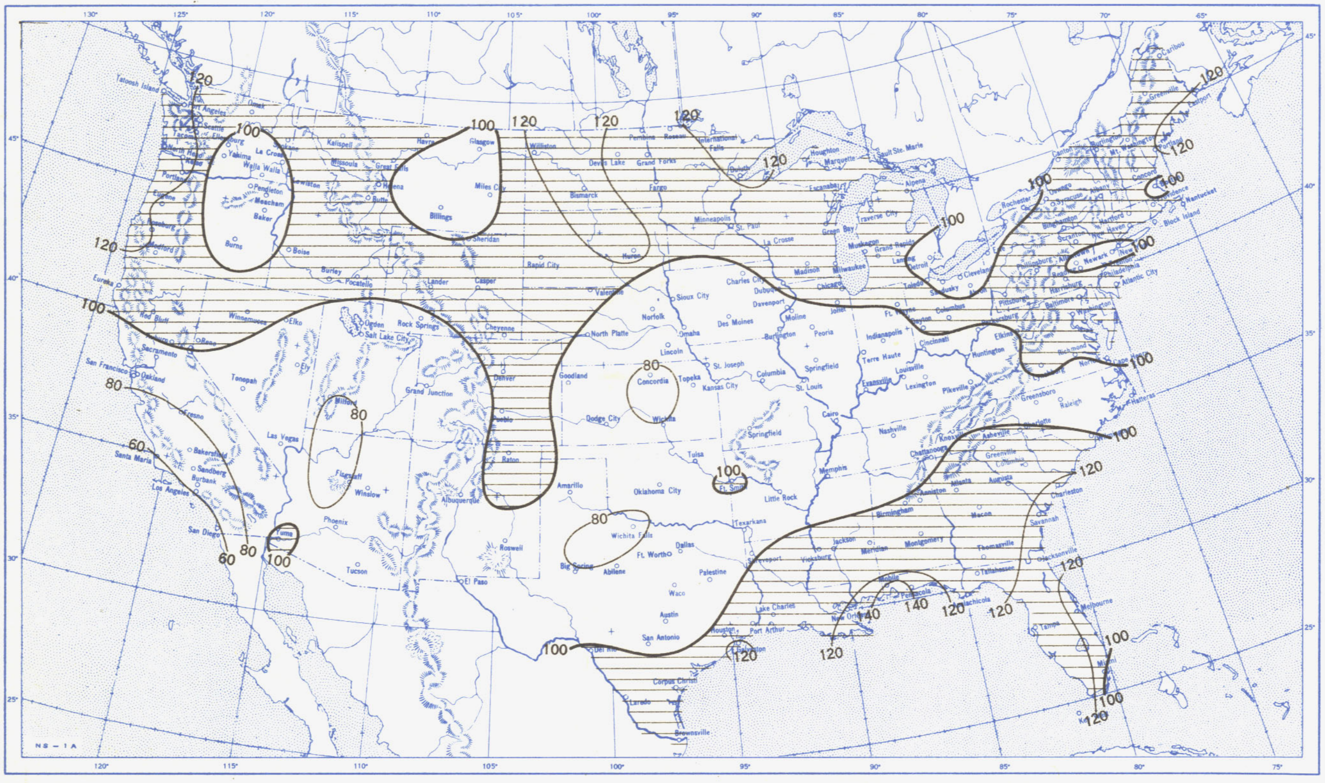


A. Amount of normal monthly snowfall is computed for Weather Bureau stations having at least 10 years of record. B. Shows depth currently on ground at 7:30 a. m. E. S. T., of the Tuesday nearest the end of the month. It is based on reports from Weather Bureau and cooperative stations. Dashed line shows greatest southern extent of snowcover during month.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, December 1953.

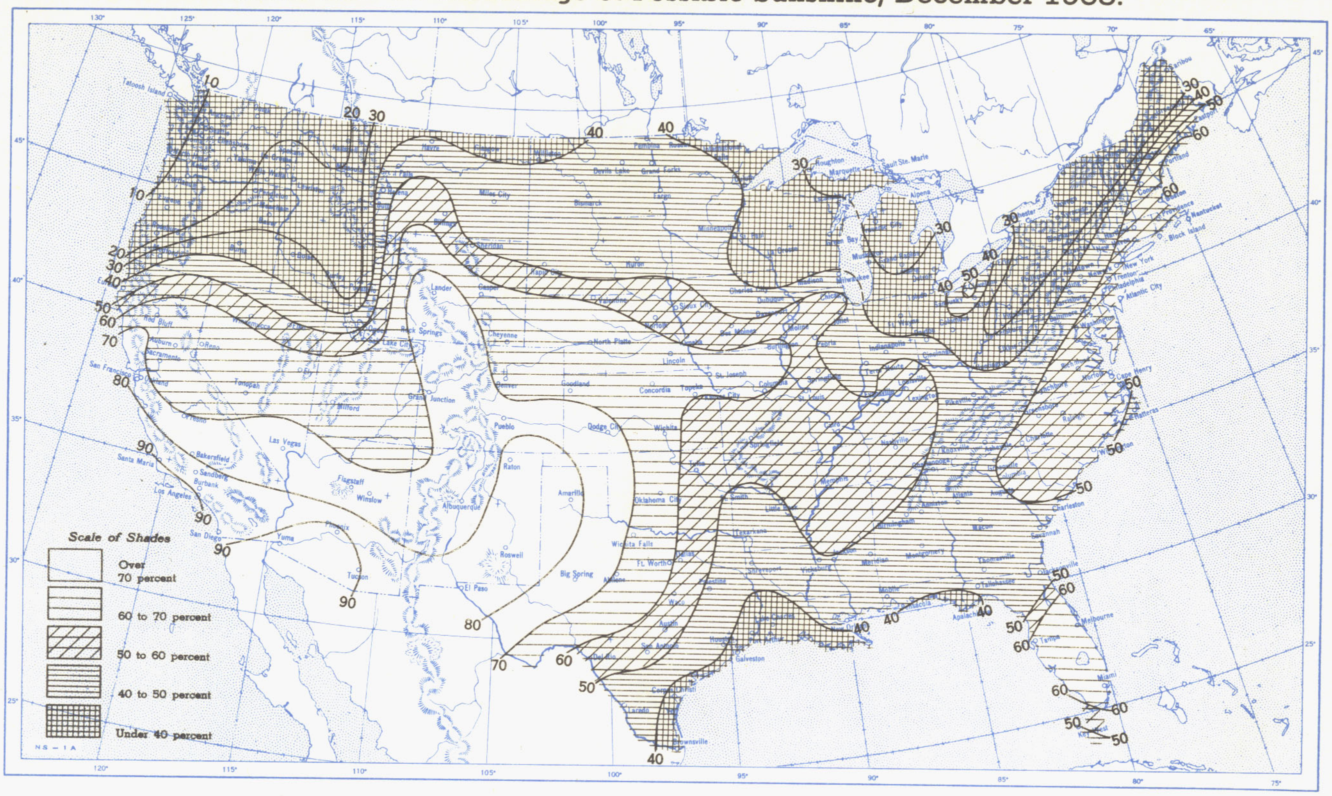


B. Percentage of Normal Sky Cover Between Sunrise and Sunset, December 1953.

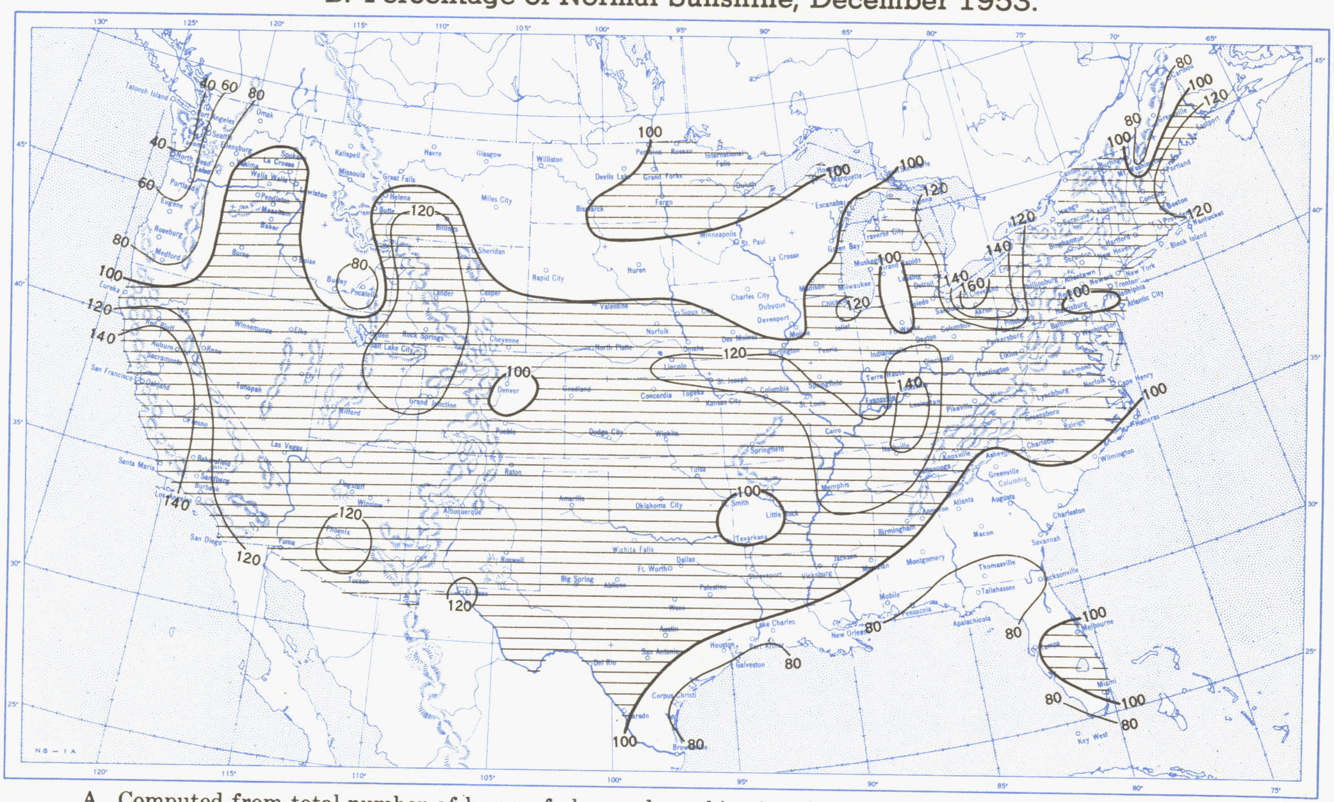


A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.

Chart VII. A. Percentage of Possible Sunshine, December 1953.



B. Percentage of Normal Sunshine, December 1953.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.

Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, December 1953. Inset: Percentage of Normal Average Daily Solar Radiation, December 1953.

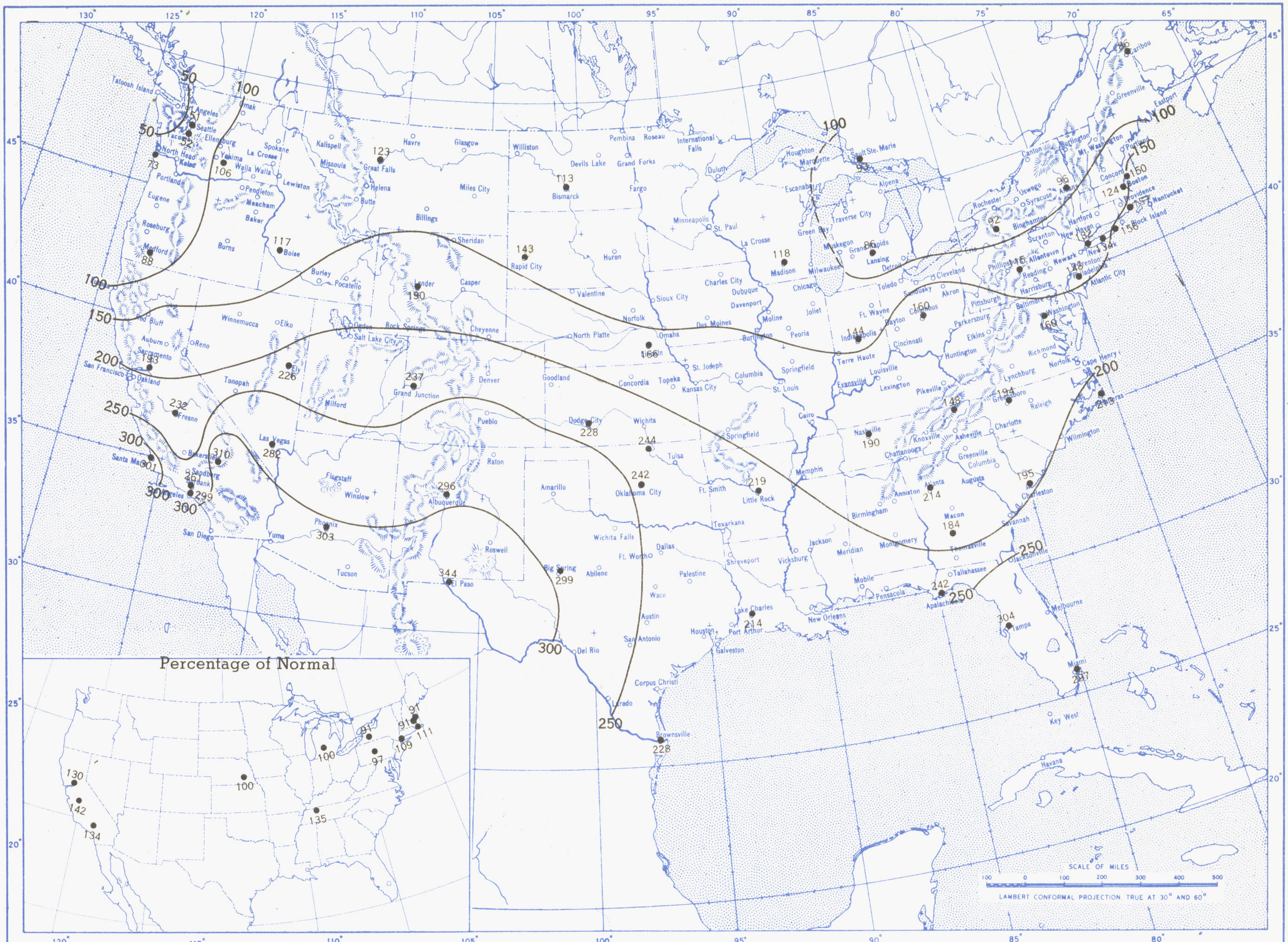
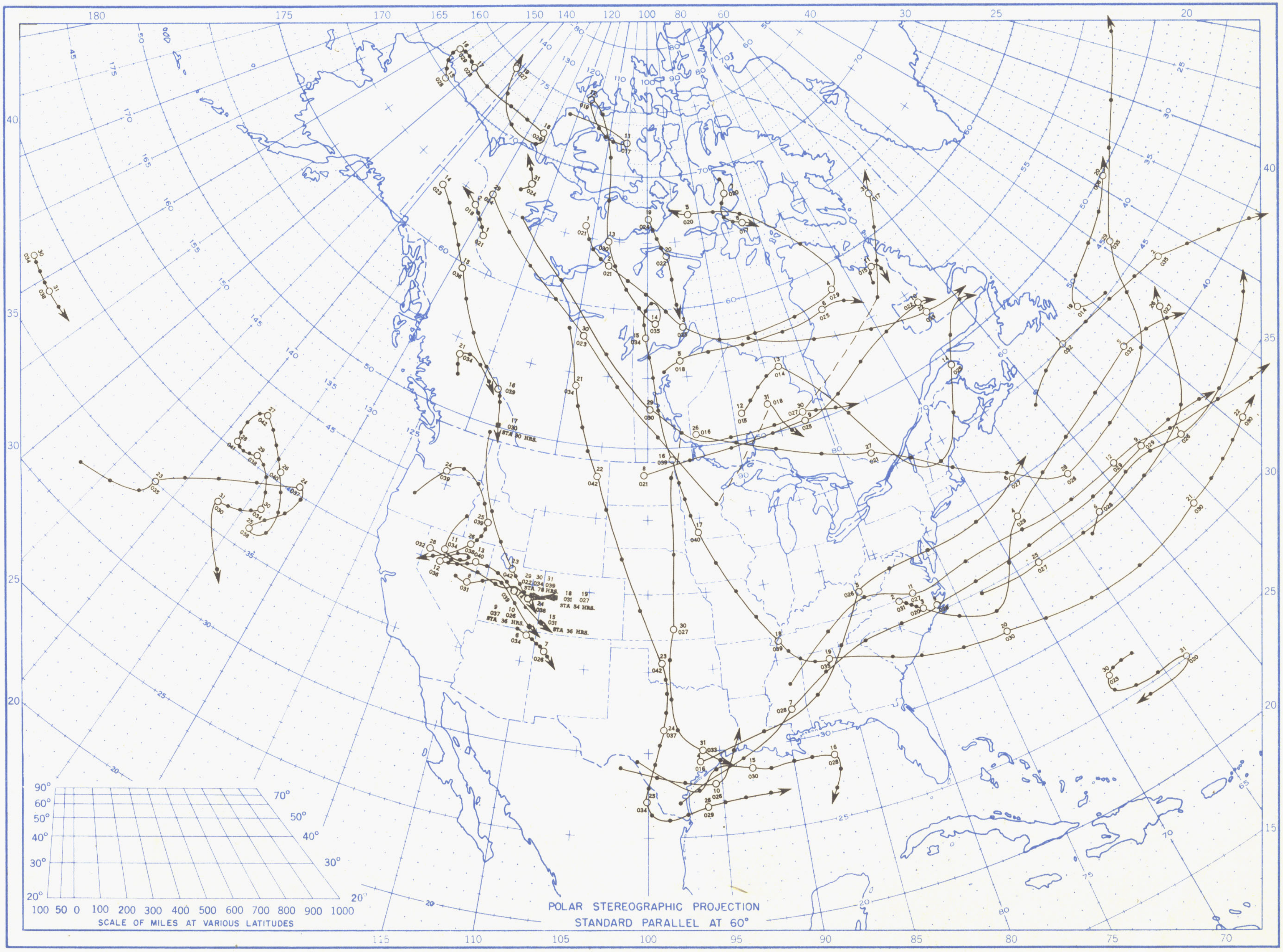


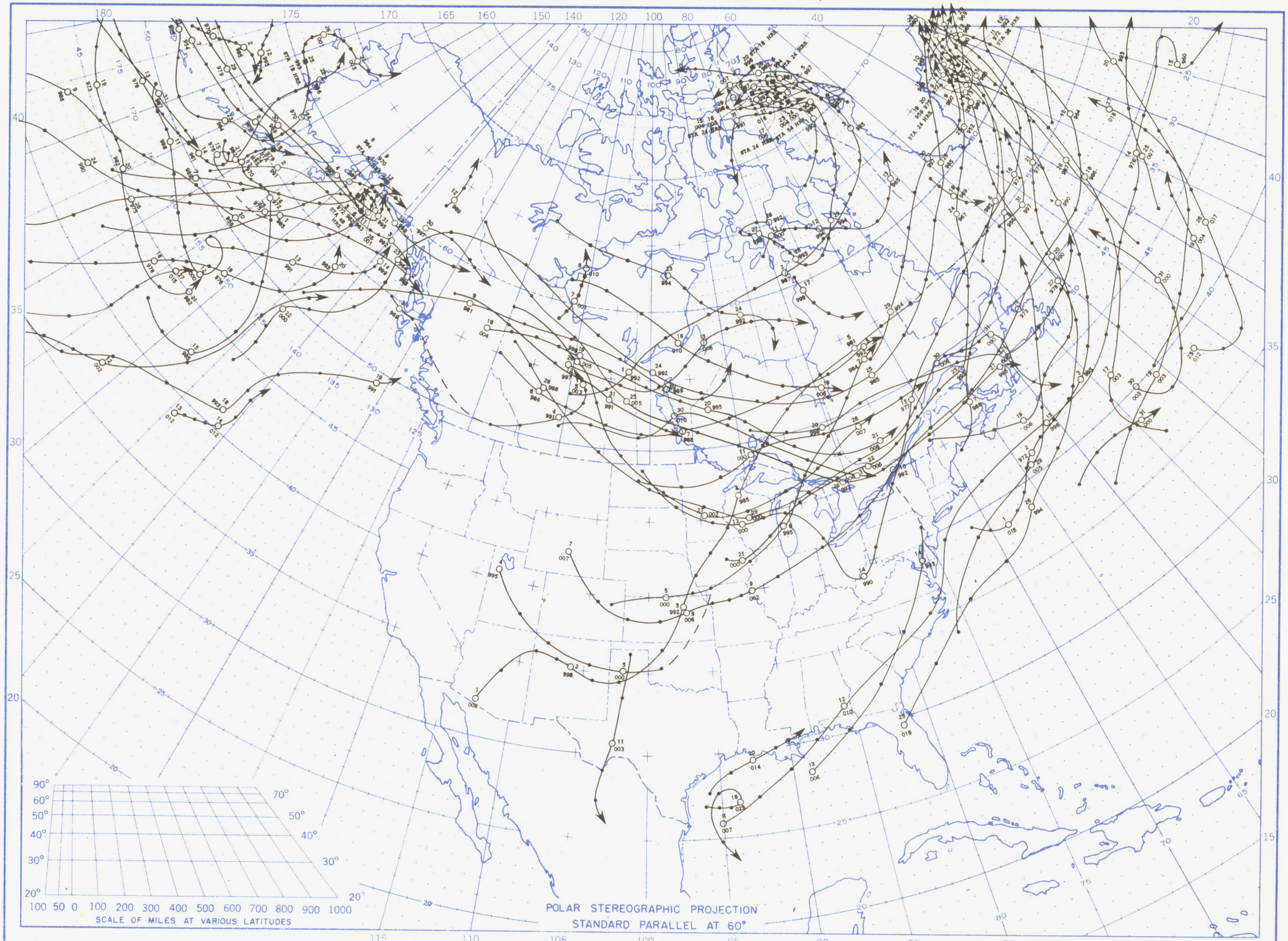
Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langleys (1 langley = 1 gm. cal. cm.$^{-2}$). Basic data for isolines are shown on chart. Further estimates are obtained from supplementary data for which limits of accuracy are wider than for those data shown. Normals are computed for stations having at least 9 years of record.

Chart IX. Tracks of Centers of Anticyclones at Sea Level, December 1953.



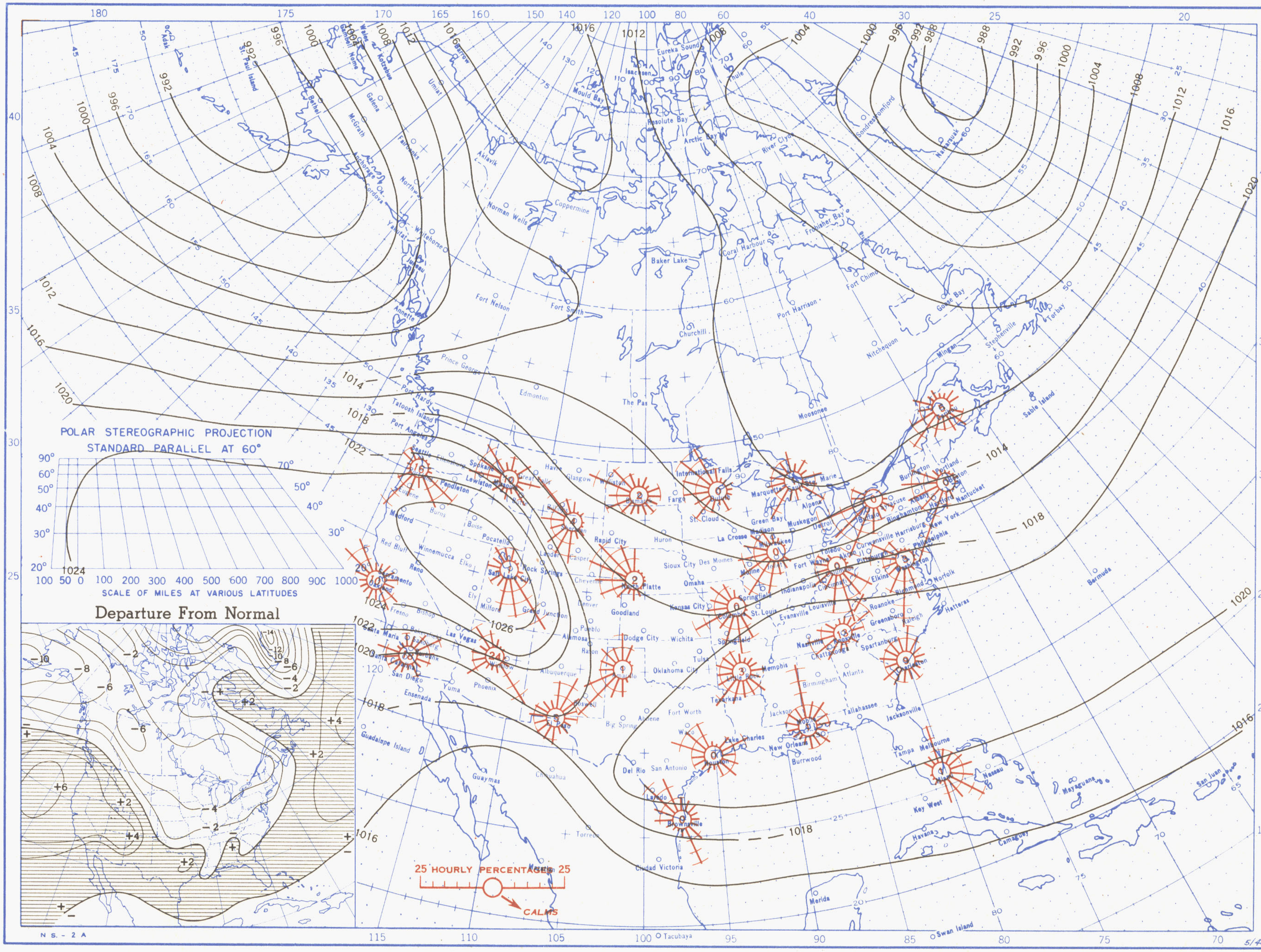
Circle indicates position of center at 7:30 a. m. E. S. T. Figure above circle indicates date, figure below, pressure to nearest millibar. Dots indicate intervening 6-hourly positions. Squares indicate position of stationary center for period shown. Dashed line in track indicates reformation at new position. Only those centers which could be identified for 24 hours or more are included.

Chart X. Tracks of Centers of Cyclones at Sea Level, December 1953.



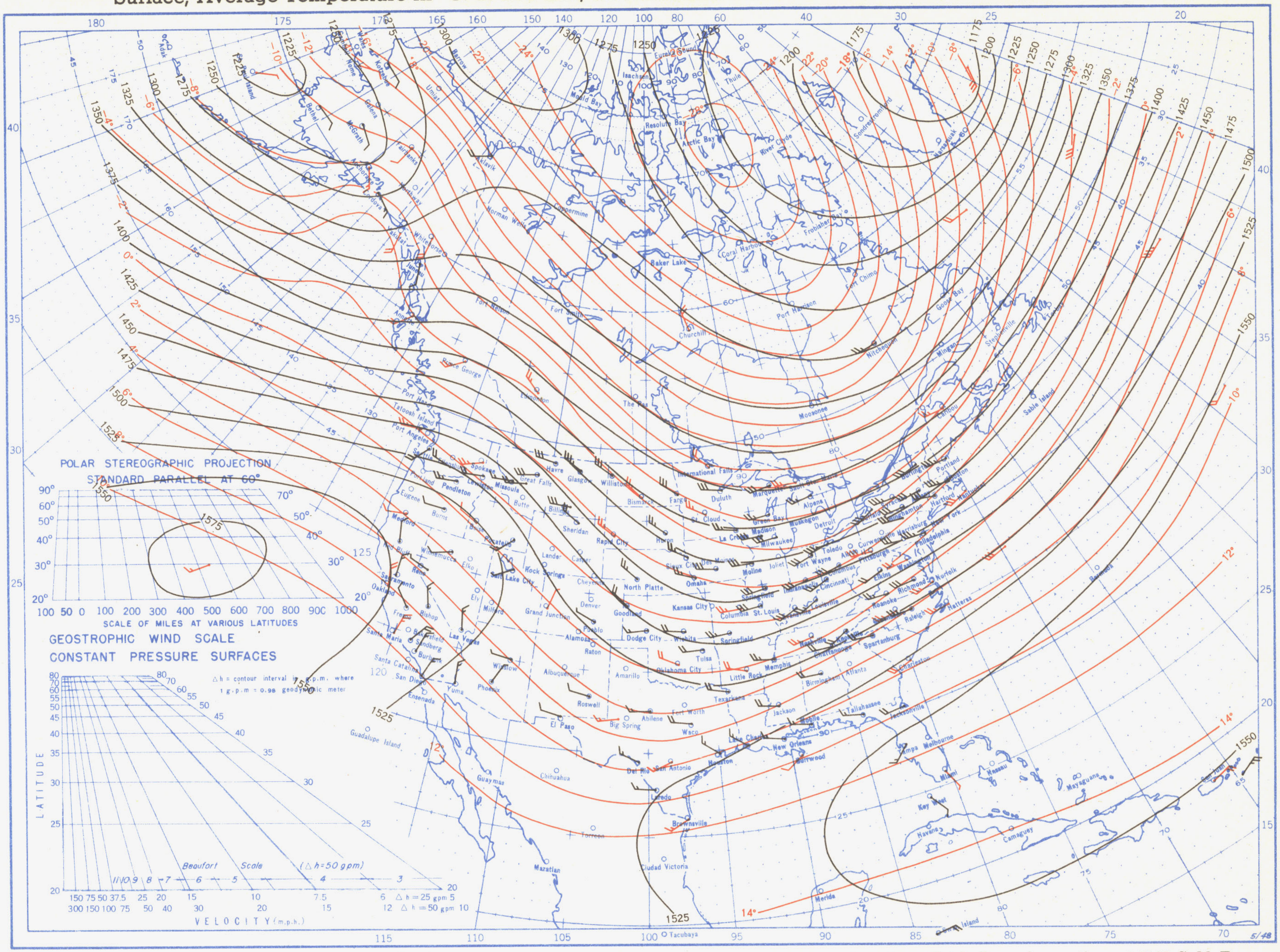
Circle indicates position of center at 7:30 a. m. E. S. T. See Chart IX for explanation of symbols.

Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, December 1953. Inset: Departure of Average Pressure (mb.) from Normal, December 1953.



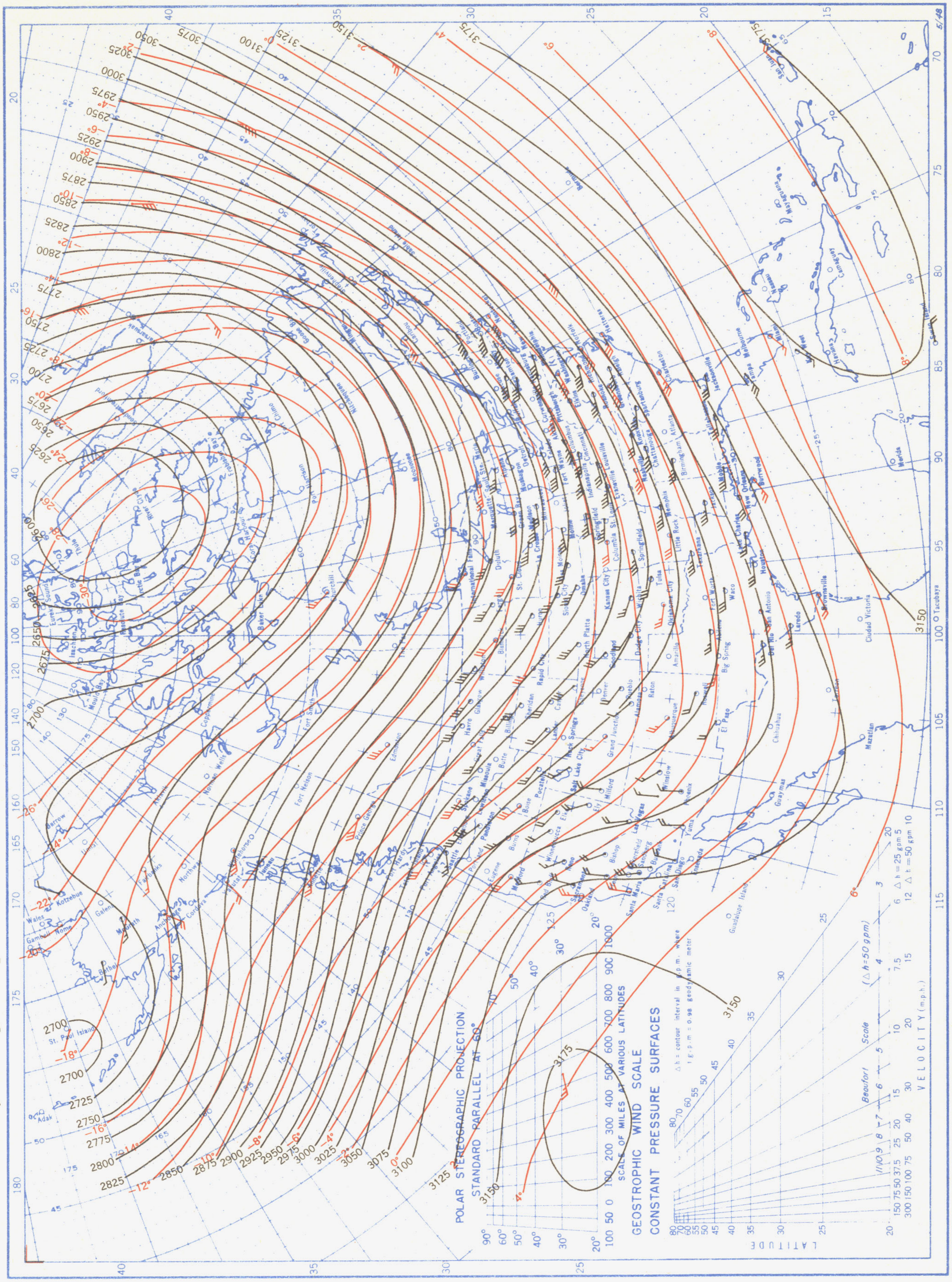
Average sea level pressures are obtained from the averages of the 7:30 a. m. and 7:30 p. m. E. S. T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° intersections in a diamond grid based on readings from the Historical Weather Maps (1899-1939) for the 20 years of most complete data coverage prior to 1940.

Chart XII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 850-mb. Pressure Surface, Average Temperature in °C. at 850 mb., and Resultant Winds at 1500 Meters (m.s.l.), December 1953.



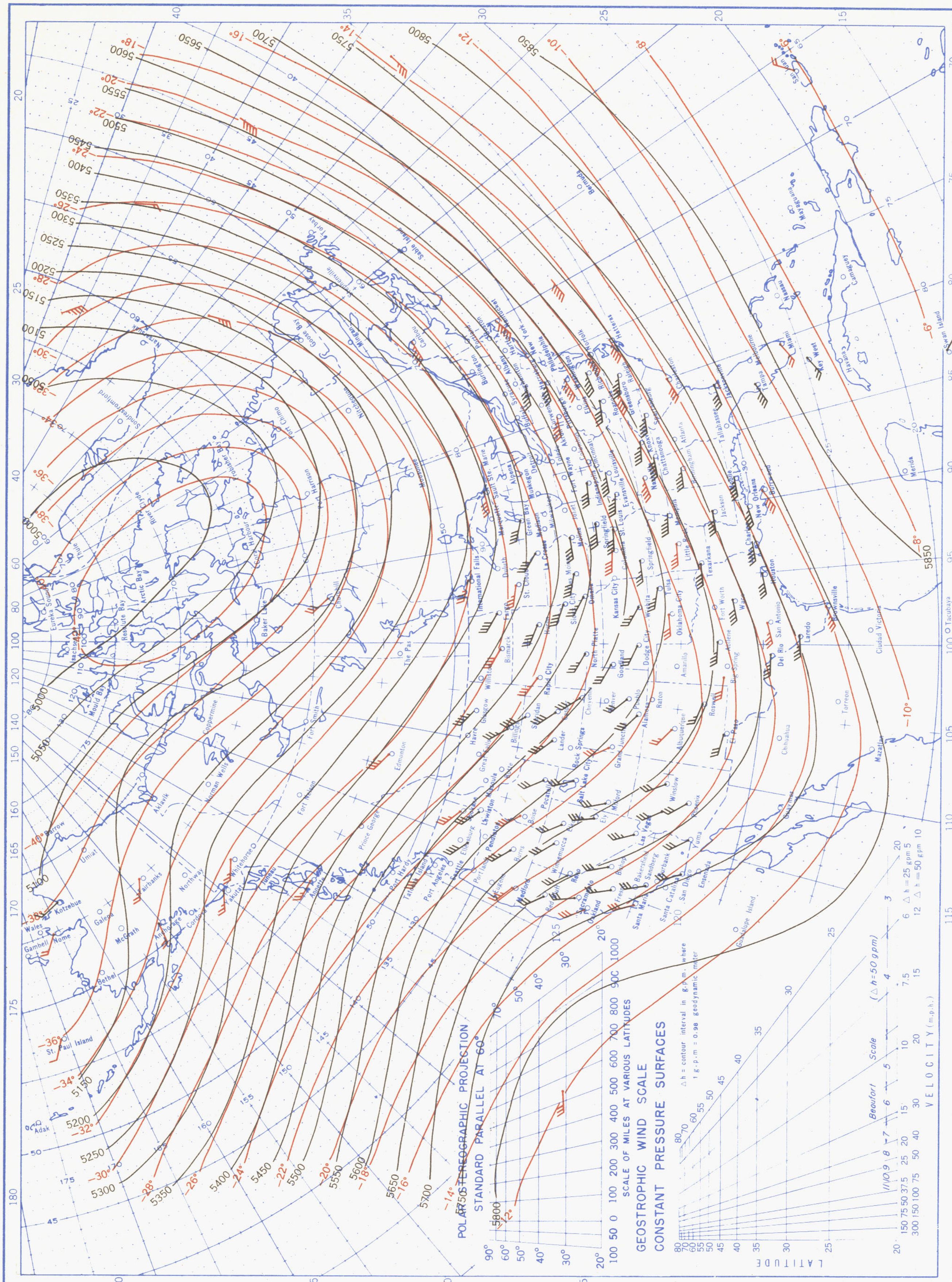
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

Chart XIII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 700-mb. Pressure Surface, Average Temperature in °C. at 700 mb., and Resultant Winds at 3000 Meters (m.s.l.), December 1953.



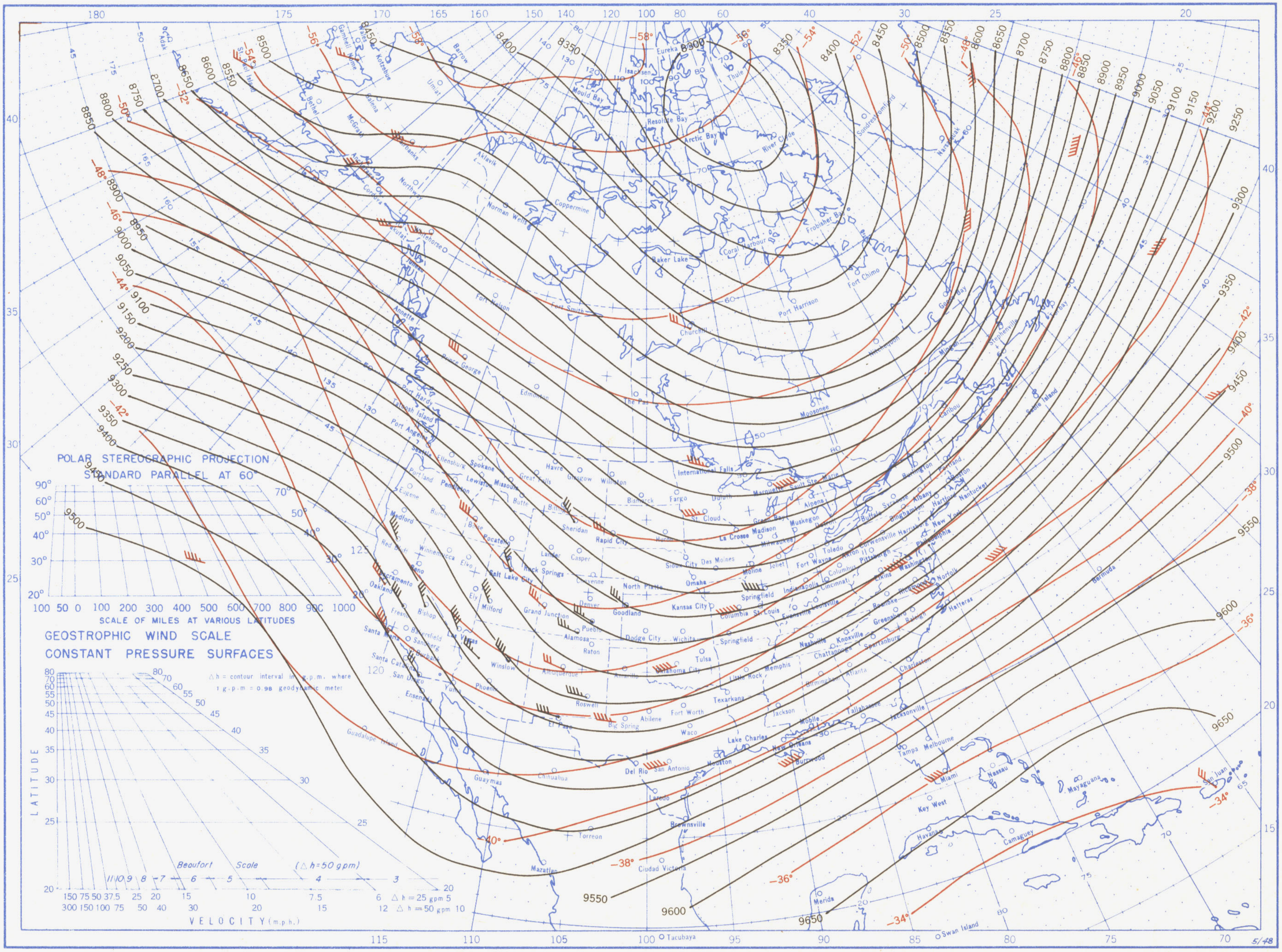
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

Chart XIV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 500-mb. Pressure Surface, Average Temperature in °C. at 500 mb., and Resultant Winds at 5000 Meters (m.s.l.), December 1953.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.

Chart XV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 300-mb. Pressure Surface, Average Temperature in °C. at 300 mb., and Resultant Winds at 10,000 Meters (m.s.l.), December 1953.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.